Progress on US Government's Estimate of the Social Cost of Carbon

CEPR & EAERE

U.S. Climate Policy in a Global Context

Michael Greenstone (University of Chicago)

EPIC ENERGY POLICY INSTITUTE AT THE UNIVERSITY OF CHICAGO

Climate Impact Lab

February 14, 2023

The Social Cost of Carbon

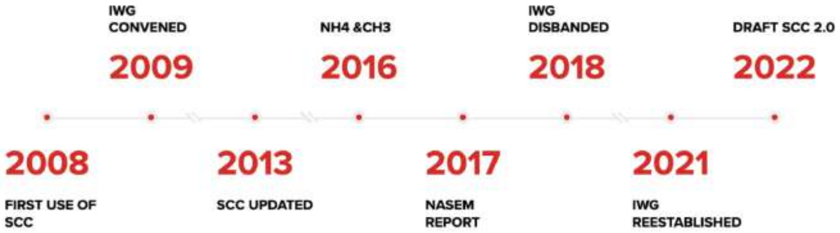
The most important number you've never heard of

The Social Cost of Carbon (SCC) - the monetary value of the damages imposed by the release of one additional ton of carbon dioxide.

For every climate change mitigation policy, the SCC is central to determining whether it is cost-effective.

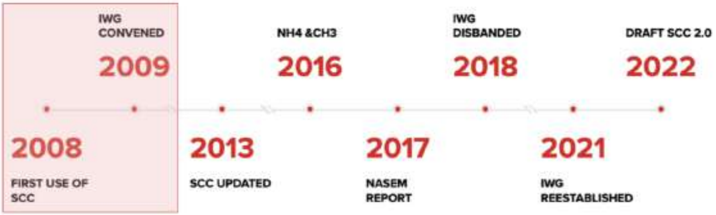
The SCC enables analysis of policy tradeoffs involving climate change mitigation.

Social Cost of Carbon Timeline



Source: Auffhammer AERE Policy Panel Presentation, 2023

Social Cost of Carbon Timeline



Technical Support Document: -
Social Cost of Carbon for Regulatory Impact Analysis -
Under Executive Order 12866 -

Interagency Working Group on Social Cost of Carbon, United States Government

Social Cost of Carbon Timeline

Social Cost of Carbon Timeline

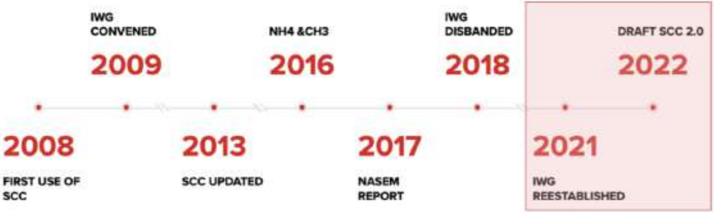
Social Cost of Carbon Timeline

PUBLISHED DOCUMENT

Executive Order 13783 of March 28, 2017

(b) The Interagency Working Group on Social Cost of Greenhouse Gases (IWG), which was convened by the Council of Economic Advisers and the OMB Director, shall be disbanded, and the following documents issued by the IWG shall be withdrawn as no longer representative of governmental policy:

Social Cost of Carbon Timeline




EPA

Report on the Social Cost of Greenhouse Gases:

Estimates Incorporating Recent Scientific Advances

September 2022

The SCC in the US Climate Policy

$$\underbrace{\$52/\text{tCO}_2}_{\substack{\text{2009-2010}\\ \text{Obama Admin.}\\ \text{IWG}}} \rightarrow \underbrace{\$1\text{-}8/\text{tCO}_2}_{\substack{\text{2017}\\ \text{Trump Admin.}\\ \text{domestic damages}}} \rightarrow \underbrace{\$52/\text{tCO}_2}_{\substack{\text{Feb 2021}\\ \text{Biden Admin.}\\ \text{``interim'' value}}} \rightarrow \underbrace{\$190/\text{tCO}_2}_{\substack{\text{Sep 2022}\\ \text{Biden Admin.}\\ \text{EPA Report}}}$$

- SCC is used to set > 80 regulations with **\$1 trillion total benefits** (2017)
- Trump Admin. used low SCC to **roll back environmental regulation**
- **11 states** guide policy with SCC (e.g. zero-emission credits in IL, NY)
- NY state grid operators have proposed using SCC as an adder in the wholesale electricity market
- Canada, France, Germany, Mexico, Norway, UK all **implement SCCs**

Outline

1. History of Climate Damage Valuations
   - Path-breaking IAM Approach is Dated
2. A New Era for Damage Estimation
   - Mortality
   - Electricity
   - Characterization of Climate and Economic Uncertainty
   - Putting it All Together: Social Cost of Carbon
3. Applying Damage Valuations to Policy

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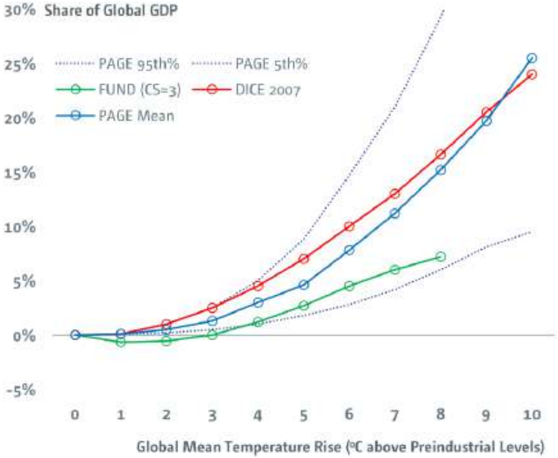
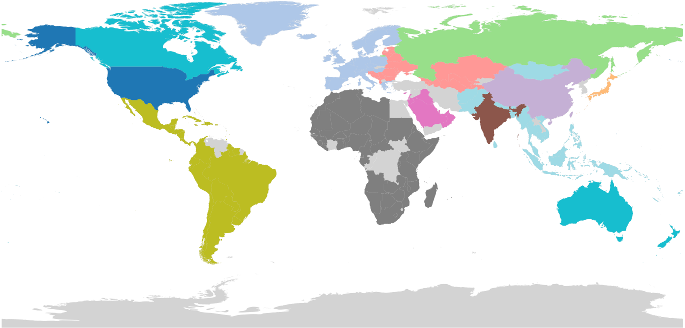
Original IAM damage assessments



Source: Interagency Working Group on SCC, 2010

Original IAM damage assessments

RICE model includes 12 regions: US, EU, Japan, Russia, Eurasia, China, India, Middle East, Africa, Latin America, other higher-income, and other non-OECD Asia (Nordhaus 2010)



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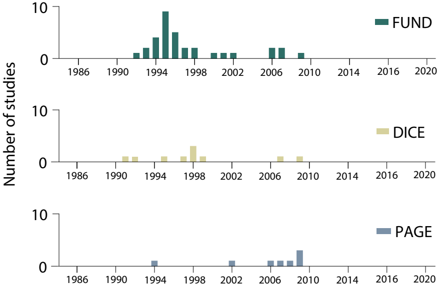
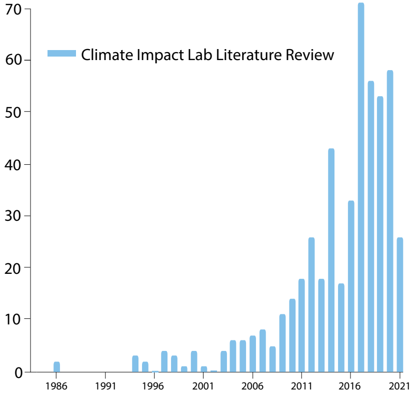
Original IAM damage assessments

"[M]uch of the research on which [the SCC models] are based is dated...damage formulations do not in many cases reflect recent advances in the scientific literature."

–*National Academies of Sciences, Engineering, and Medicine (2017)*





Empirical publications informing these models

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Climate Impact Lab

www.impactlab.org

Berkeley
UNIVERSITY OF CALIFORNIA

EPIC
ENERGY POLICY INSTITUTE
AT THE UNIVERSITY OF CHICAGO

Rhodium Group

RUTGERS
Institute of Earth, Ocean, and
Atmospheric Sciences

A new era for climate damage estimation

The Climate Impact Lab has developed the **Data-driven Spatial Climate Impact Model (DSCIM)** based on the following **Guiding principles**: Global climate damage calculations should...

$\longrightarrow$ be based on best-available **empirical evidence**

$\longrightarrow$ be based on best-available **climate models**

$\longrightarrow$ be **globally representative**

$\longrightarrow$ account for **adaptation** and **its costs**

$\longrightarrow$ value **uncertainty** and **unequal impacts**

Modular damage analysis

Mortality — heat and cold deaths (Carleton et al, *QJE 2022*)

All cause mortality (<5) All cause mortality (>64)

All cause mortality (5-64)

Agriculture — crop yields (Hultgren et al, *in review*)

Maize Wheat Rice

Soybean Sorghum Cassava

Energy — energy and electricity demand (Rode et al, *Nature, 2021*)

Electricity consumption Other fuels consumption

Labor — labor supply & disamenity (Rode et al, *2022*)

High risk labor Low risk labor

Coastal — sea level rise and storm damages (Depsky et al, *in review*)

Sea level rise inundation SLR $\times$ tropical cyclone surge

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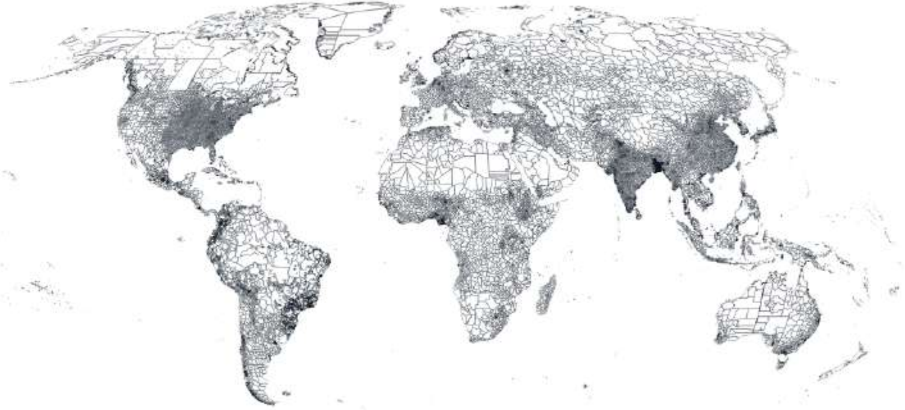
Integration — valuing marginal damages (Nath et al, *2022*)

Intertemporal discounting Valuing inequality

Pricing risk

A new era for climate damage estimation

Climate Impact Lab: ~25,000 regions capture subnational inequality of damages



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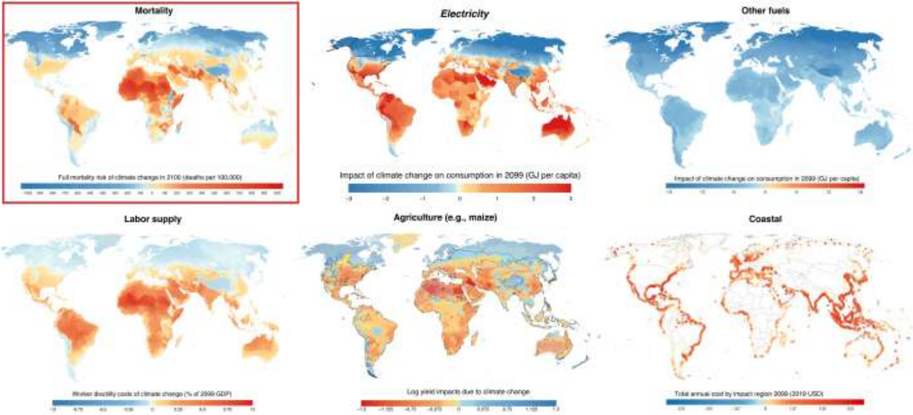
Global climate change damages across sectors



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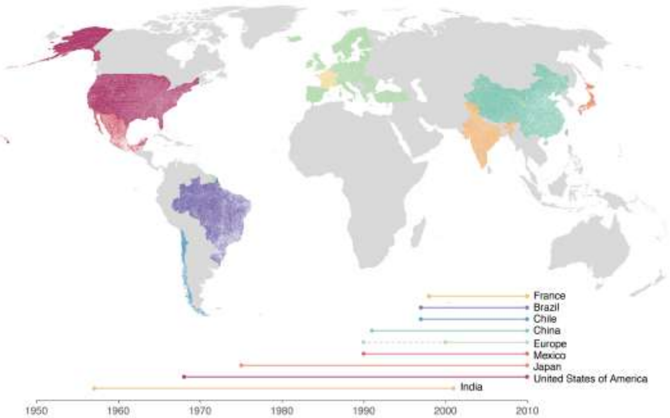
THE QUARTERLY JOURNAL OF ECONOMICS

VALUING THE GLOBAL MORTALITY CONSEQUENCES OF CLIMATE CHANGE ACCOUNTING FOR ADAPTATION COSTS AND BENEFITS*

Tamma Carleton
Amir Jina
Michael Delgado
Michael Greenstone
Trevor Houser
Solomon Hsiang
Andrew Hultgren
Robert E. Kopp
Kelly E. McCusker
Ishan Nath
James Rising
Ashwin Rode
Hee Kwon Seo
Arvid Viaene
Jiacan Yuan
Alice Tianbo Zhang

Mortality data coverage

Subnational mortality records covering 55% of the global population



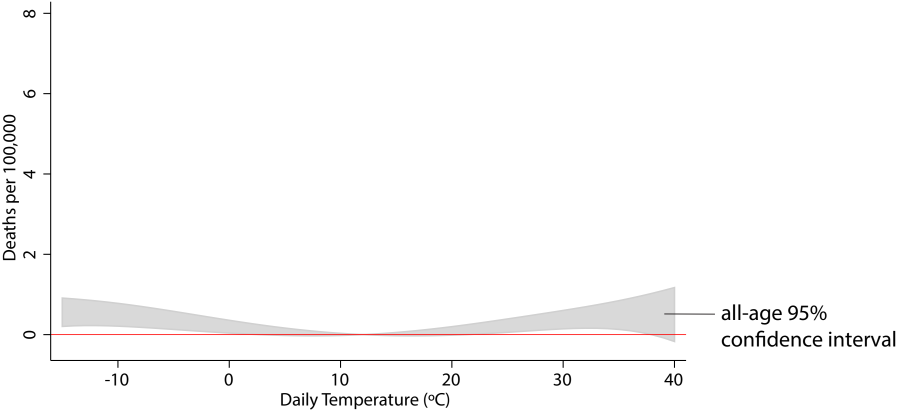
Age-specific annual mortality rates at ∼county level

Carleton et al. (QJE, 2022)

Quantifying climate damages from mortality

Extreme heat and extreme cold impact mortality rates:

$$Mortality_{ait} = g_a(Temperature_{it}) + q_{ac}(Precipitation_{it}) + \alpha_{ai} + \delta_{act} + \epsilon_{ait}$$



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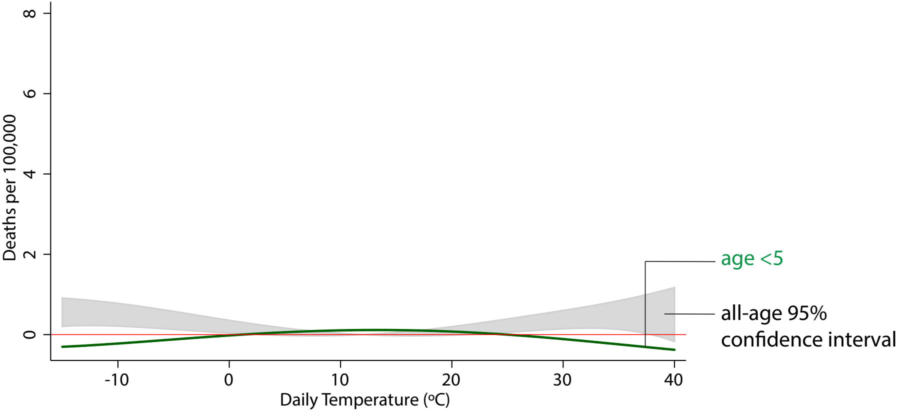

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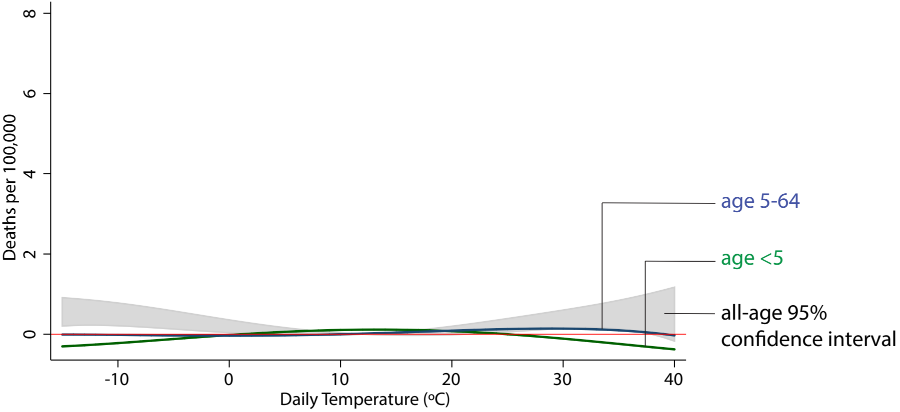

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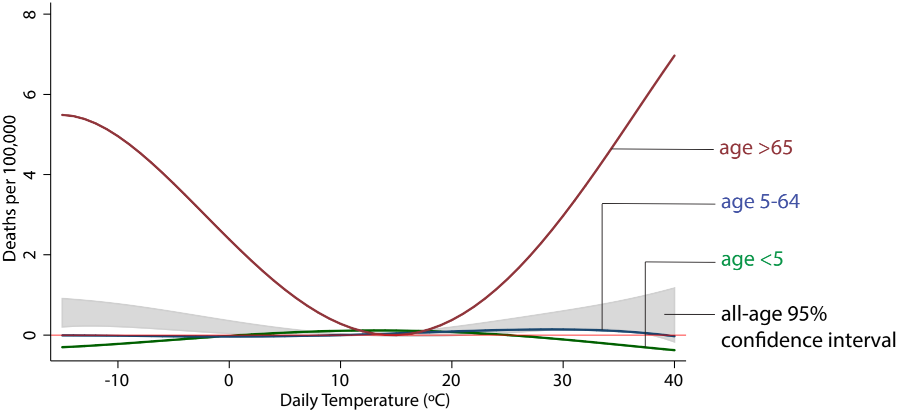

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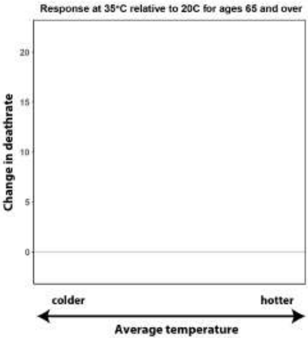
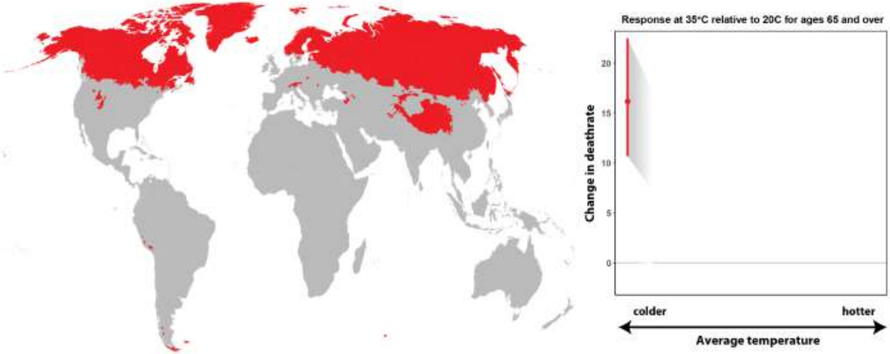
Mortality damages vary by climate due to adaptation



Effect day at 35°C relative to 20°C for ages 65 and over.
Coefficient calculated for deciles of *TMEAN* (red shaded area).

Mortality damages vary by climate due to adaptation



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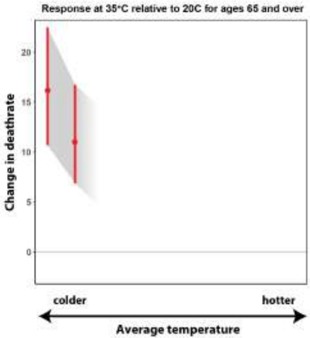

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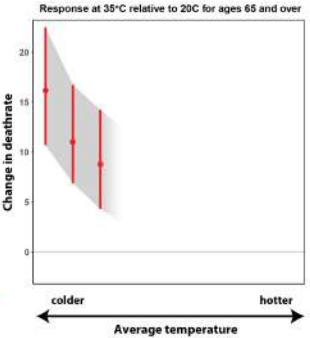

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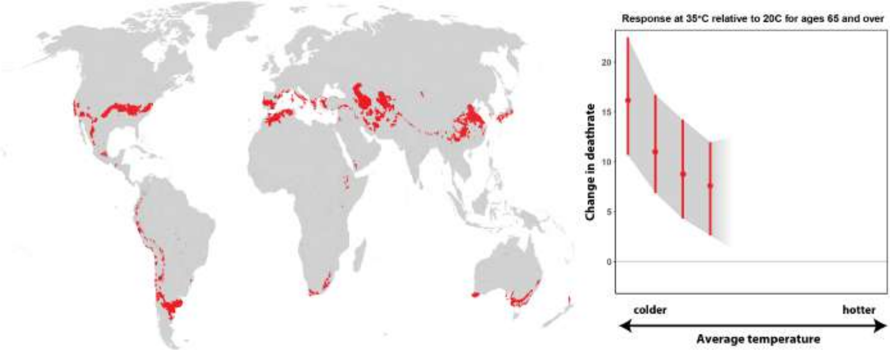

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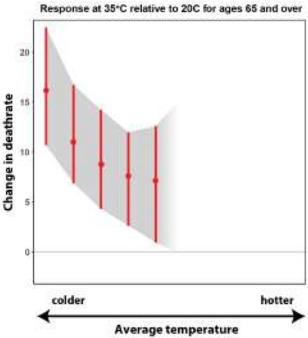

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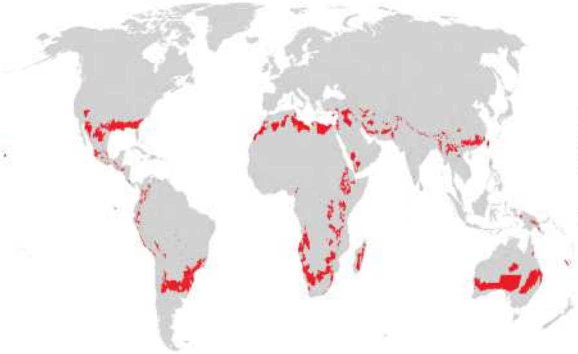

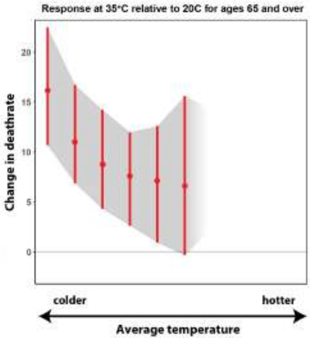

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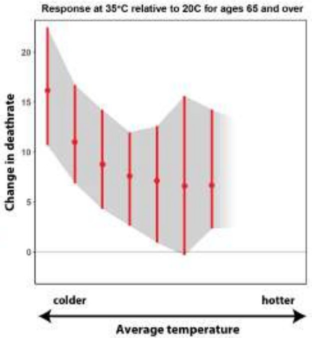

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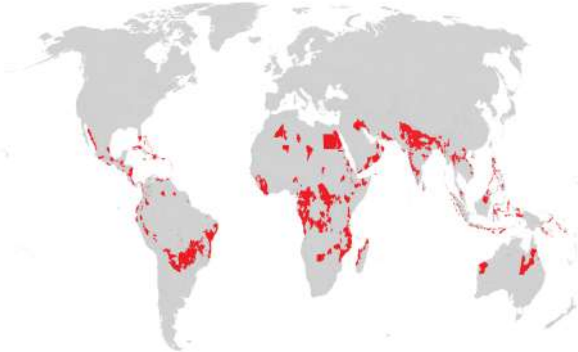

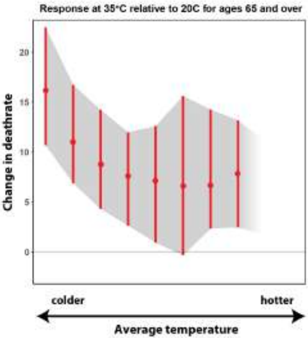

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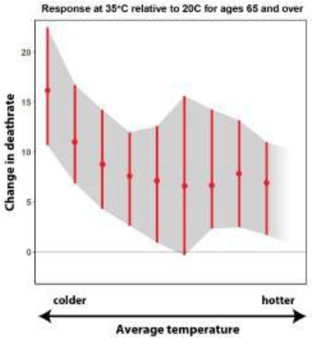

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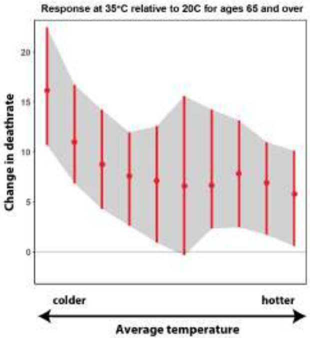

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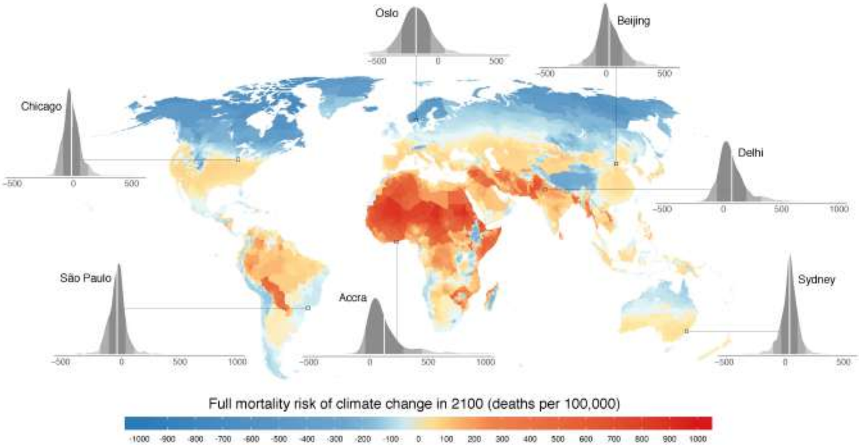
Mortality impacts are distributed unequally



Δ Mortality + adapt. costs due to warming; 2099, high-emissions scenario

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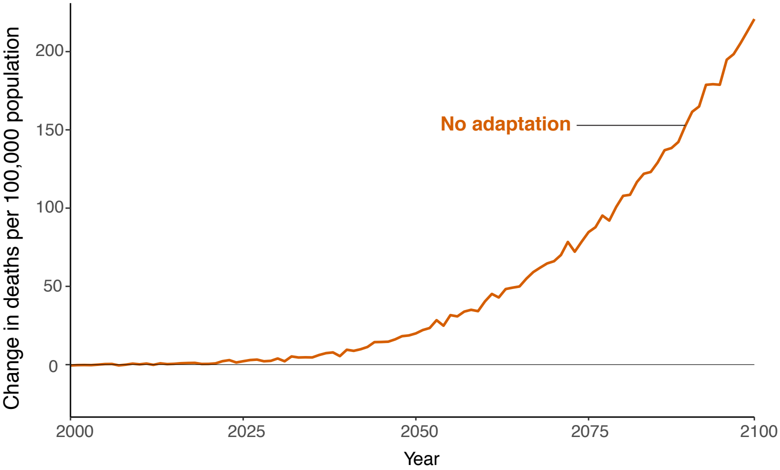
Global climate change damages to mortality



Scenario: RCP 8.5 (high emissions) & SSP3

Current global average mortality rate: 770 deaths per 100,000

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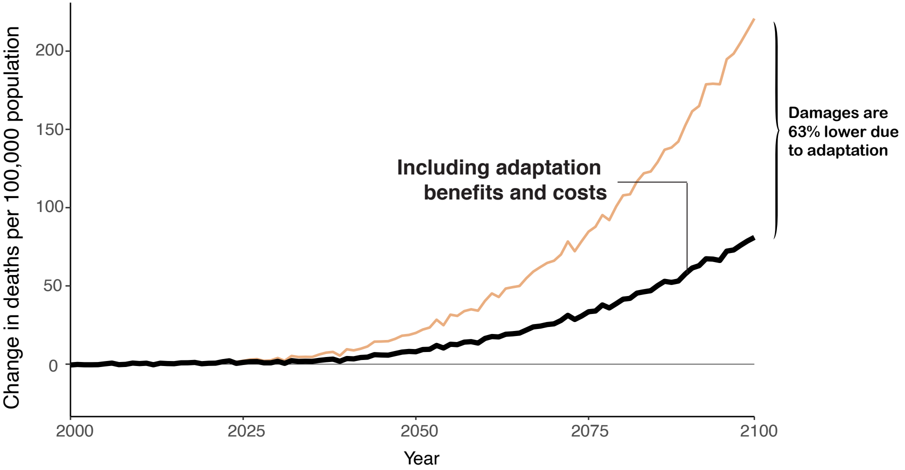

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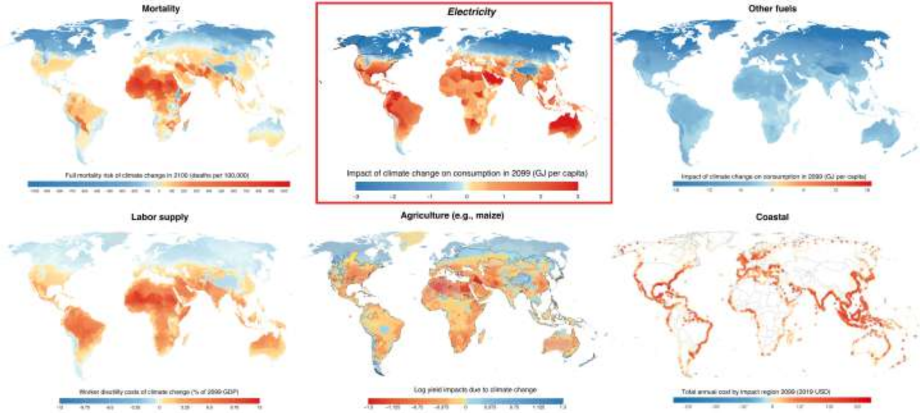

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nature

Article

Estimating a social cost of carbon for global energy consumption

Ashwin Rode[1✉], Tamma Carleton[2,3], Michael Delgado[4], Michael Greenstone[3,5], Trevor Houser[4], Solomon Hsiang[3,6✉], Andrew Hultgren[1,5], Amir Jina[3,7], Robert E. Kopp[8,9], Kelly E. McCusker[4], Ishan Nath[10], James Rising[11] & Jiacan Yuan[12,13,14,15]

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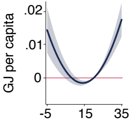
Energy data coverage

International Energy Agency (IEA) provides energy consumption data from 146 countries (1971 - 2012)

Quantifying climate damages from electricity consumption

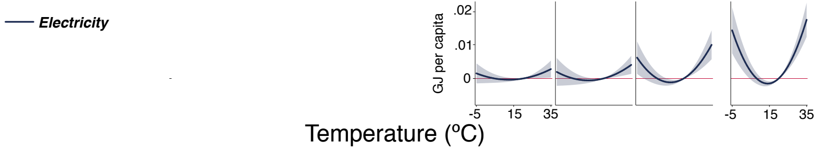
— *Electricity*



Temperature (ºC)

Poorest Decile → ***Richest Decile***

Quantifying climate damages from electricity consumption



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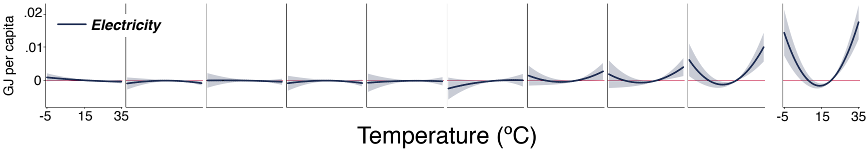

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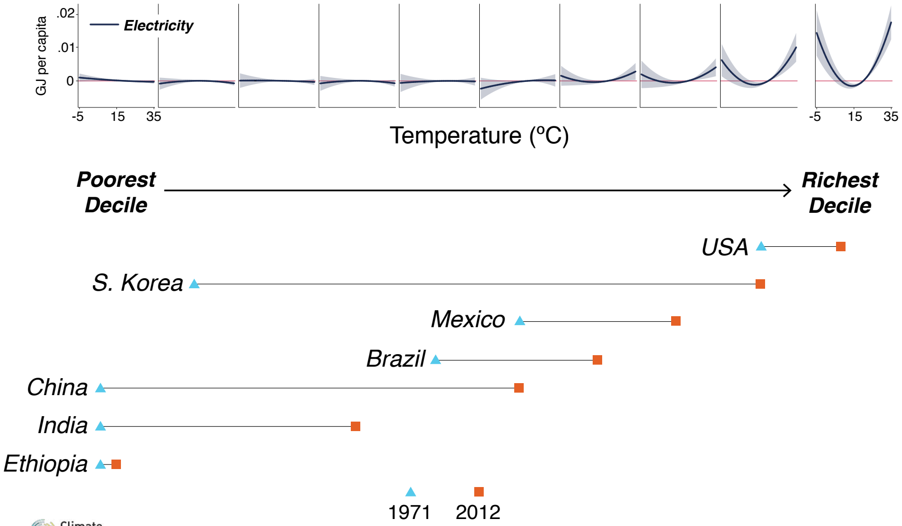

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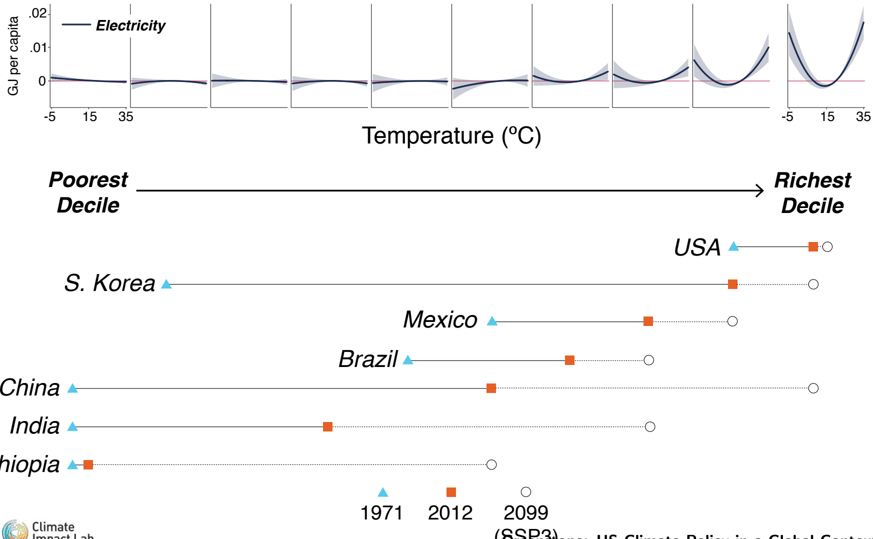

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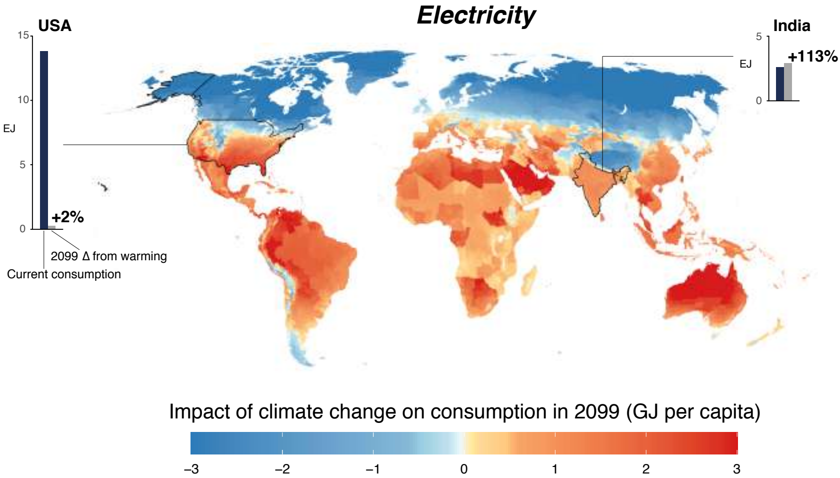

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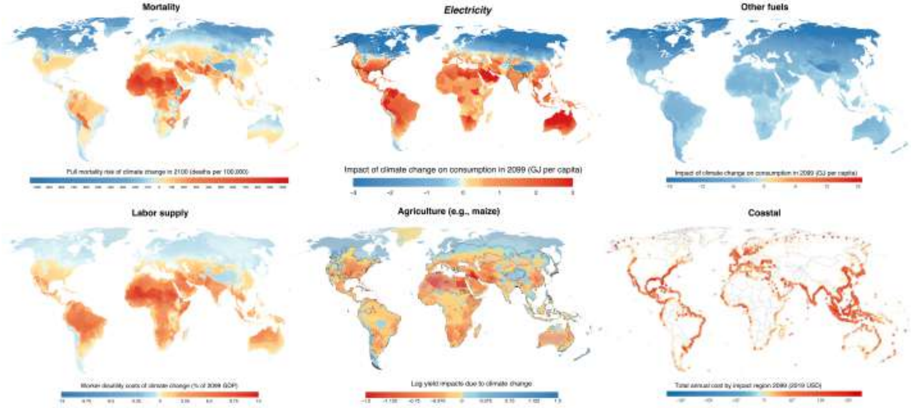
New Approach Allows Measuring Impact for Each Sector



A new era for climate damage estimation

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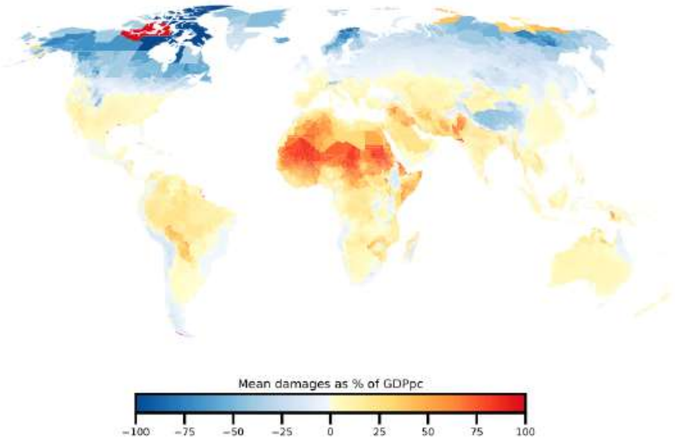

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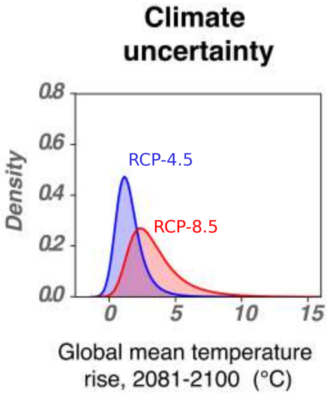
Multiple sources of uncertainty in climate change impacts



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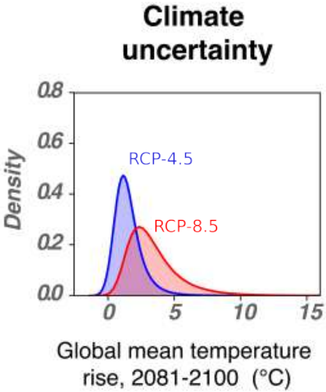

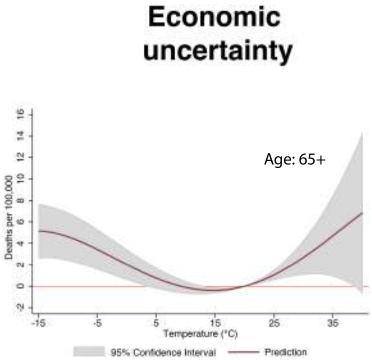

Additional sources of uncertainty: emissions and socioeconomic scenarios

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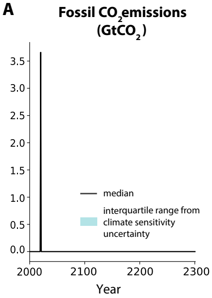
3. Applying Damage Valuations to Policy

Calculating a Social Cost of Carbon



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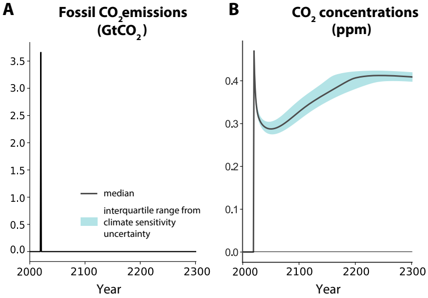
Calculating a Social Cost of Carbon



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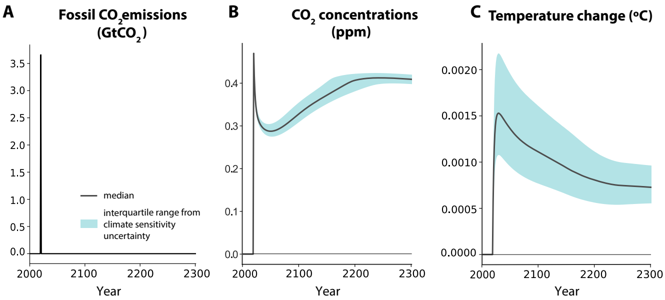

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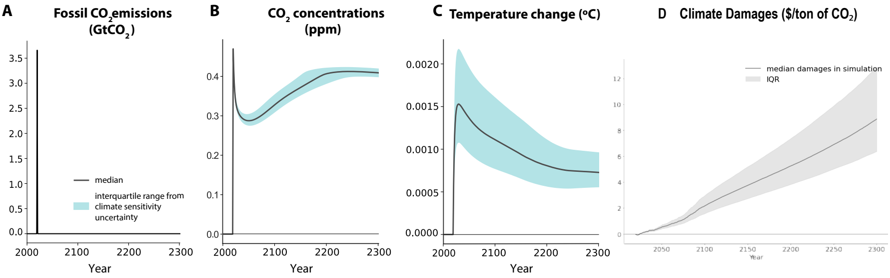

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Empirically founded SCCs vs Original IAM Approach

	Original IAM Approach	DSCIM

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Empirically-based damage functions	X	✓
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Complete set of sectors	?	X
Social cost of carbon	**$51**	**$189**

DSCIM estimates include: mortality, electricity, heating fuels, agriculture, labor disutility, coastal damages

Breakdown of Economic Damages

How costly are damages to rich versus poor regions?

Income Groups	Population billions	**SCC** Contribution USD	*Damages in 2099 %of Region's 2099 GDP*
OECD	1.4	-$11.3	1.5%
Rest of World	5.8	$186.2	8.0%
Low Income	0.7	$14.1	12.0%
Total	7.9	189	6.4

Population shares: OECD (17%) Low Income (9%) RoW (74%)
Income groups are defined using 2021 data.
Scenario: RCP8.5 & SSP3
Source: World Bank (2022) and CIL

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Monetary damages from current emissions

Total CO_2 emissions since 1790: 1.96 trillion

How costly are current annual emissions?

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How costly are current annual emissions?

DSCIM Social Cost of Carbon: $189

	Annual CO_2 Emissions *Excluding LUCF, Mt*	**Economic damages** *billions of USD*
China	11,472	$2,168
USA	5,007	$946
European Union	2,793	$528
India	2,709	$512
World	37,124	$7,016

Source: World Bank (2021)

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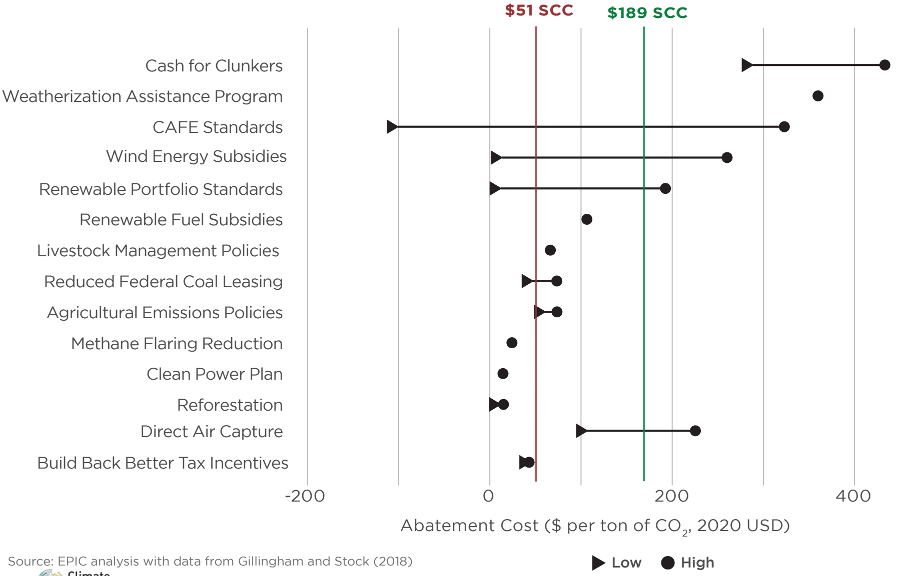
Outline

1. History of Climate Damage Valuations
   - Path-breaking IAM Approach is Dated
2. A New Era for Damage Estimation
   - Mortality
   - Electricity
   - Characterization of Climate and Economic Uncertainty
   - Putting it All Together: Social Cost of Carbon
3. Applying Damage Valuations to Policy

Identifying cost-effective climate policy actions



Source: EPIC analysis with data from Gillingham and Stock (2018)

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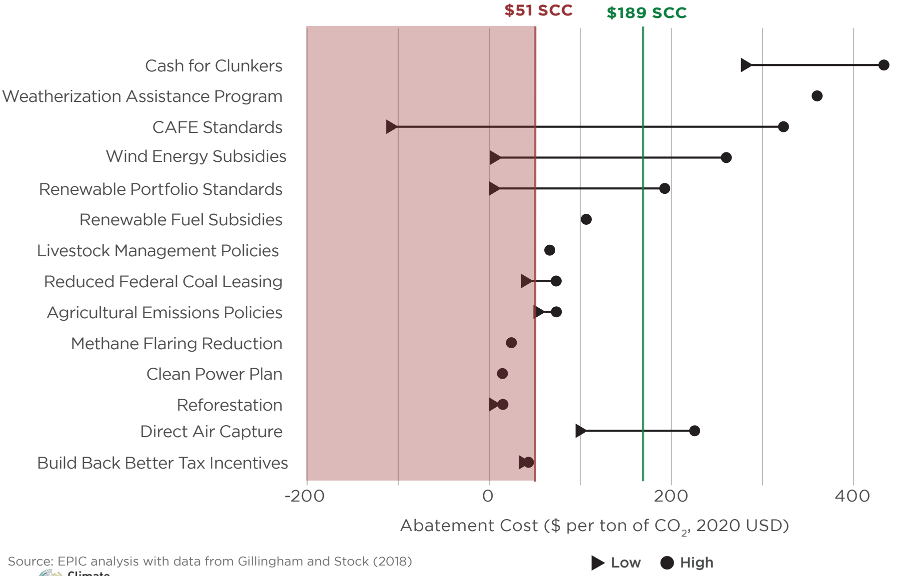
Identifying cost-effective climate policy actions



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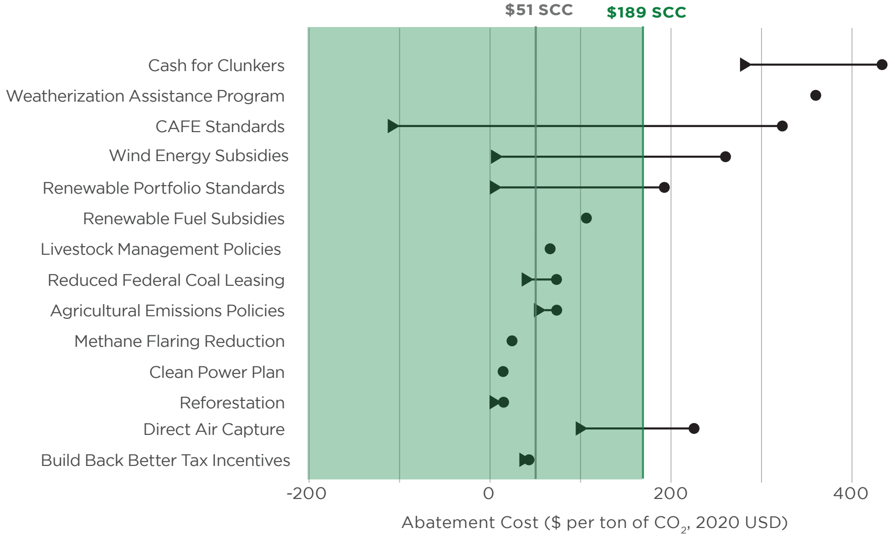
Identifying cost-effective climate policy actions



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